B.Sc Part - I

Ising Model

Transition of non ferromagnetic state to ferromagnetic phase transition of second kind without any external field (B). Some of the spins of the atom becomes spontaneously polarised in the same direction T_c (cure temp.)
This creates a macroscopic magnetic field.
When $T > T_c$ then spin gets random orientation and so No net magnetic field B.

In Ising Model N fixed latice sites form n demensional periodic potential and spin variable S_i $(i = 1, 2 --- N)$

$$S_i = +1 \text{ (spin up) and } S_2 = (-1) \text{ (spin down)}$$

Energy of whole system

$$E_I(S_i) = -\sum_{\langle i,j \rangle} \epsilon_{ij} S_i S_j - \mu H \sum_{i=1}^{N} S_i \quad \text{--- (1)}$$

Here I = Ising $\langle i,j \rangle$ = Nearest Neighbour pair of spin

$$\langle i,j \rangle = \langle j,i \rangle$$

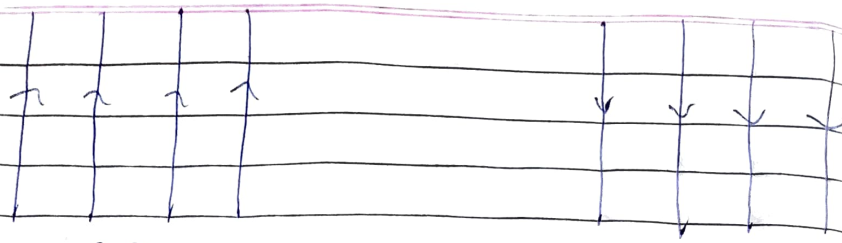
ϵ_{ij} = Interaction energy μH = Interaction energy associated with H.

Now for the case:
For Isotropic interaction $\epsilon_{ij} = \epsilon$

$$E_I(S_i) = -\epsilon \sum S_i S_j - \mu H \sum_{i=1}^{N} S_i \quad \text{--- (2)}$$

$\epsilon > 0$ For ferromagnetism

$\epsilon < 0$ For Anti ferromagnetism



$\epsilon > 0$ Ferromagnetism

$\epsilon < 0$ Antiferromagnetism

$\langle i, j \rangle = \left(\frac{\nu N}{2}\right)$ ν = No of nearest neibours of any given sites

So ν and ϵ_{ij} depends upon geometry of lattice.

For the case $\epsilon > 0$ the partition function is

$$Z = \sum_{S_1} \sum_{S_2} \sum_{S_N} e^{-\beta E_I (S_I)} \quad \text{—— (3)}$$

S_I = range ± 1 so we get $(2)^N$ terms.

Bragg - William Approximation

from Ising Model $E_I(S_I) = -\epsilon \sum_{\langle i,j \rangle} S_i S_j - \mu H \sum_i S_i$ —— (4)

Let N_+ = No of spins which $S_i = 1$

$\frac{N_+}{N}$ = Probability of finding spin +1

N_- = No of spins $S_i = -1$

$\frac{N_-}{N}$ = Probability of finding spin = −1

$$E_I = -\frac{1}{2} \nu N \epsilon \left(\frac{N_+}{N} - \frac{N_-}{N}\right)^2 - \mu H \left(N_+ - N_-\right) \quad \text{—— (5)}$$